2017 Final Report Summary Sheet

Grantee Information

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Project Title: Nitrogen management systems in tile-drained fields: Optimizing yields while minimizing losses

Institution: University of Illinois

Primary Investigator: David/Gentry

NREC Project # 2014-5-360847-320

2014-3-8

Is your project on target from an IMPLEMENTATION standpoint? ☒ **Yes** ☐ **No**
If you answered "no" please explain:

Is your project on target from a BUDGET standpoint? ☒ **Yes** ☐ **No**
If you answered "no" please explain:

Based on what you know today, will you meet the objectives of your project on-time and on-budget? ☒ **Yes** ☐ **No**
If you answered "no" please explain:

Have you encountered any issues related to this project? ☐ **Yes** ☒ **No**
If you answered "yes" please explain:

Have you reached any conclusions related to this project that you would like to highlight? ☒ **Yes** ☐ **No**
If you answered "yes" please explain:

- As in 2016, cereal rye after corn (before soybean) decreased tile nitrate concentrations below 2 ppm.
- The effect of cereal rye on tile nitrate continued through the next drainage season.
- Applying anhydrous in late February without an inhibitor created increased tile nitrate losses, which were similar to tile nitrate losses from fall fertilizer N application with an inhibitor.
- Cumulative tile loads over the past two years show that side-dress treatments reduce tile nitrate loads (without sacrificing crop yields).

Have you completed any outreach activities related this project? Or do you have any activities planned? ☒ **Yes** ☐ **No**
If you answered "yes" please explain and provide details for any upcoming outreach:

During 2017, outreach activities included 13 invited presentations by Lowell Gentry at various events such as: the Crop Management Conferences held throughout the state; annual meetings by IFCA and LICA, and local meetings (i.e. Ford/Iroquois County Extension and the Champaign County Farm Bureau. Collectively, we estimate that >1500 people attended these meetings and conferences. In addition, we hosted 2 field days this summer to present our findings from both the Douglas and Piatt County projects. We also helped create a cover crop guide book from the findings of this and our other NREC studies.

Additional Notes:

2017 Annual Report for NREC Project

Nitrogen Management Systems in Tile-Drained Fields: Optimizing Yields while Minimizing Losses

Lowell Gentry, Mark David, and Emerson Nafziger
University of Illinois at Urbana-Champaign

Synopsis:

It is well established that there are substantial nitrate losses from corn and soybean production systems; however, there is not a good understanding of the relationship of current and newly developing nitrogen management systems to nitrate loss from tile lines. Timing, split applications, and cover crop effects on nitrate losses need multi-year measurements to better understand the effects of weather, as well as the resulting crop yields. Because nitrate losses from tile systems are likely to stay at the forefront of state nutrient reduction strategies, we need to be able to tell producers which nitrogen management systems are most likely to reduce nitrate losses without reducing yields. This study will provide the needed data for that, by making multi-year tile nitrate measurements on a field in east-central Illinois where 36 individual tile lines will be monitored with six treatments, each replicated three times. Treatments will range from all N applied in the fall (with inhibitor) to split spring-side-dress with cover crop, the latter representing what we expect to be the "best management practice" for minimizing nitrate loss.

Objectives

The overall goal of this project is to more fully understand current and new nitrogen management systems on corn yields and nitrate losses from tile-drained fields in Illinois.

Specific objectives are to:

1. To conduct on-farm field trials of current and new N management systems for typical corn/soybean rotations, evaluating both the yield response and the tile losses of nitrate.
2. To determine when and why tile nitrate losses occur in these management systems, during both corn and soybean rotations.

Length of Project

This project has been funded for 4 years; however, 2015 was a set-up years as fall fertilizer N and cover crops treatments were not established in 2014 and the entire research area was planted to corn in 2014 which required 200 lbs/A of fertilizer N to corn in 2015 (full fertilizer N rate is 160 lbs/A in 2016 and 2017 because rotation was established. We have now completed 2 full years of data collection with all treatments imparted on a corn-soybean rotation. We have an agreement with the landowner and the University Board of Trustees through 2020 at this site.

Treatments

1. Full rate of NH_3 (160 lb N/acre) applied in the fall after November 1 with nitrapyrin.

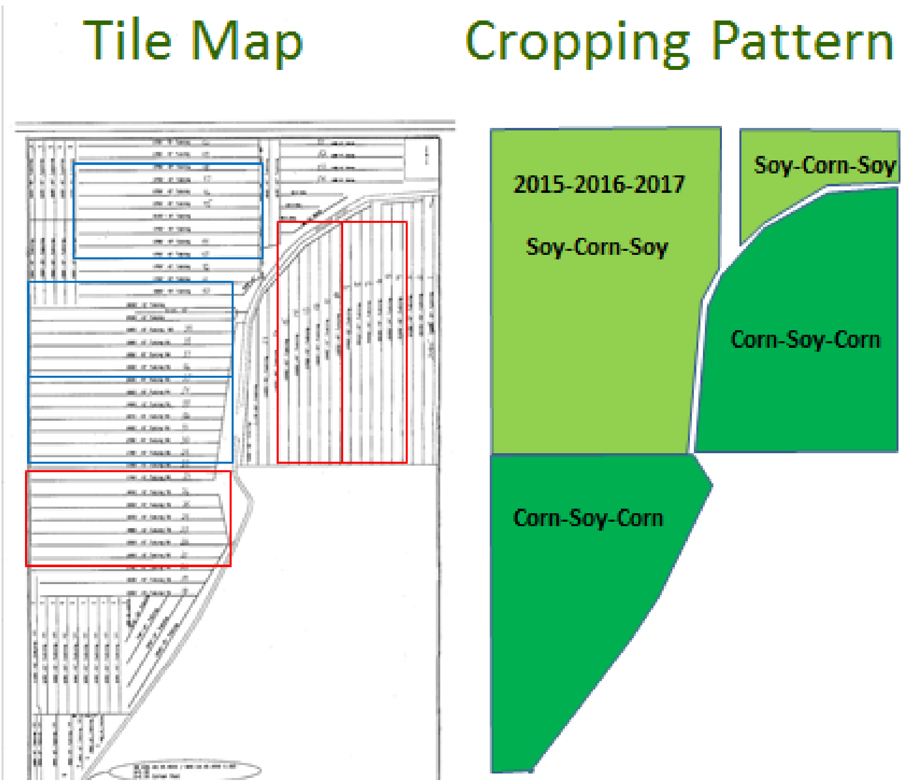
2. 80 lb N applied as NH_3 in the fall with nitrapyrin followed by 40 lb N/acre as UAN at planting followed by 40 lb side-dressed as UAN.

3. Full rate applied as NH_3 (no nitrapyrin) in early spring (to before planting), with placement between rows by RTK.

4. Reduced rate (120 lb N/acre) applied as NH3 (no nitrapyrin) in early spring (before planting), with placement between rows by RTK.

5. 80 lb N applied as NH_3 early spring (before planting) followed by 80 lb N as UAN side-dressed.

6. Treatment #5 but with cover crops (oats-radish mixture seeded into standing soybean crop the previous early fall; cereal rye after corn).



The above tile map shows the blocking of the 6 N treatments and locations of the 3 replicates. Cropping pattern is shown for the study period (2015-2017).

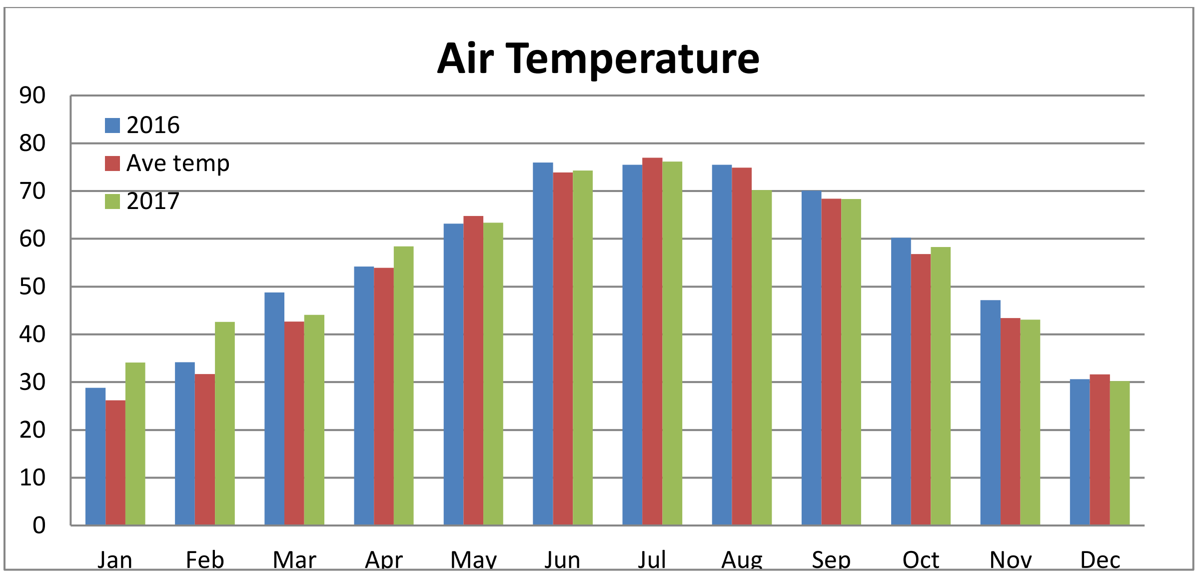
Field Operations:

Field work was challenging with several periods of field flooding in the spring of 2017; however, all treatments were imparted and planting was done early as possible thanks to the vigilance of Dan Schaefer. Field operations for the past year are as follows:

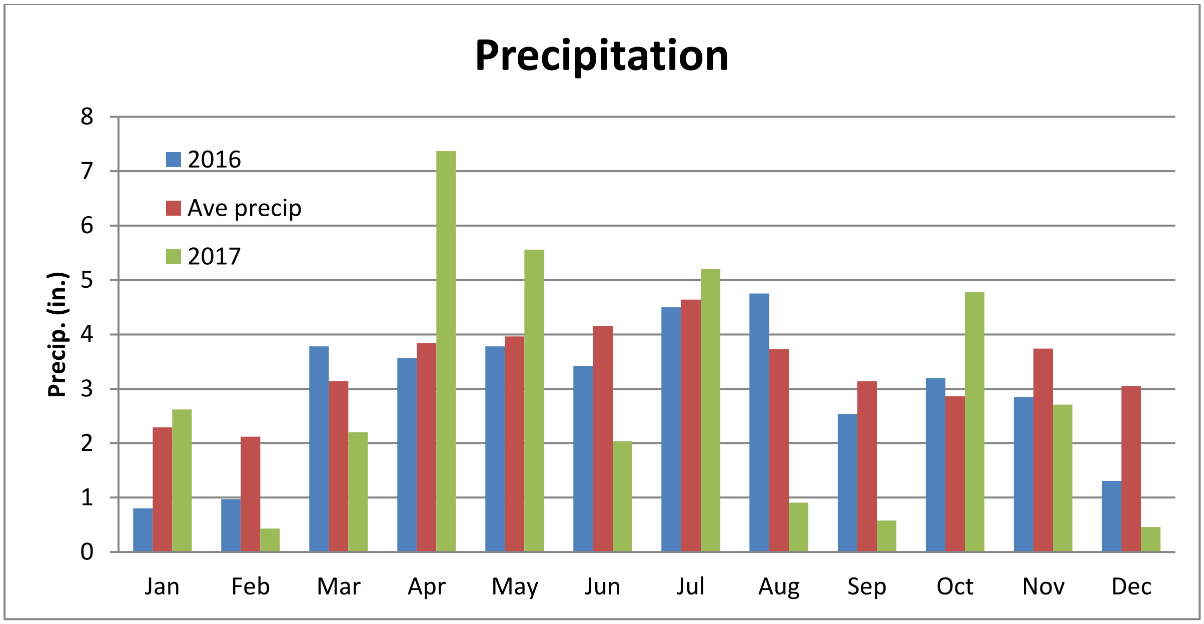
- Sept. 2, 2016: Cereal rye planted after corn; oat and radish planted after soybean

- Nov. 16, 2016: Fall N fertilizer applied on corn N rate trial and strips were made
- Nov. 17, 2016: Fall N fertilizer applied and strips were made
- Feb. 28, 2017: Spring N fertilizer applied
- Mar. 4, 2017: Spring N fertilizer applied on corn N rate trial
- April 30, 2017: Cereal rye terminated and biomass collected
- May 18, 2017: Corn planted; N applied at planting for the 3 way split N application treatment
- June 1, 2017: No-till soybean planted
- June 16, 2017: Side-dress N fertilizer applied
- Oct. 2-4, 2017: Soybean harvested
- Oct. 5, 2017: Oat and radish planted
- Oct. 16-19, 2017:Corn harvested
- Oct. 22, 2017: Cereal rye planted on plot #5
- Oct. 29, 2017: Cereal rye planted on plots #10 and 27
- Nov. 14, 2017: Strip till for corn
- Nov. 15, 2017: Fall N fertilizer applied
- Dec. 1, 2017: Strip-till for soybean
- Dec 4, 2017: Oat and radish biomass sampling

Results and Discussion:

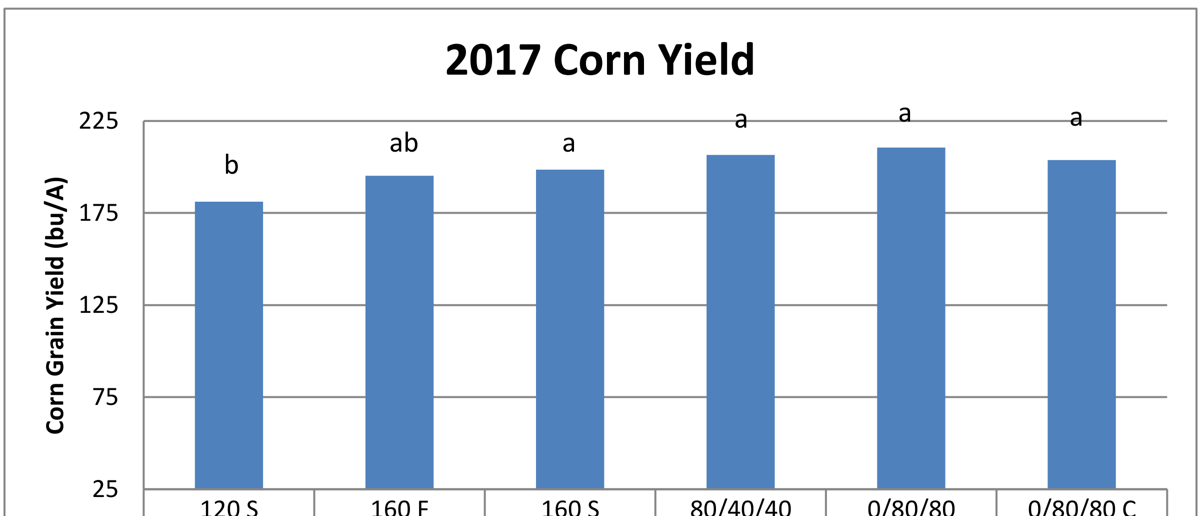


Monthly air temperatures in January and February of 2017 were well above the 30 yr average, while August was cooler than average.



Monthly precipitation in April, May and October were well above the 30 yr average, while June, August, and September were much drier than average.

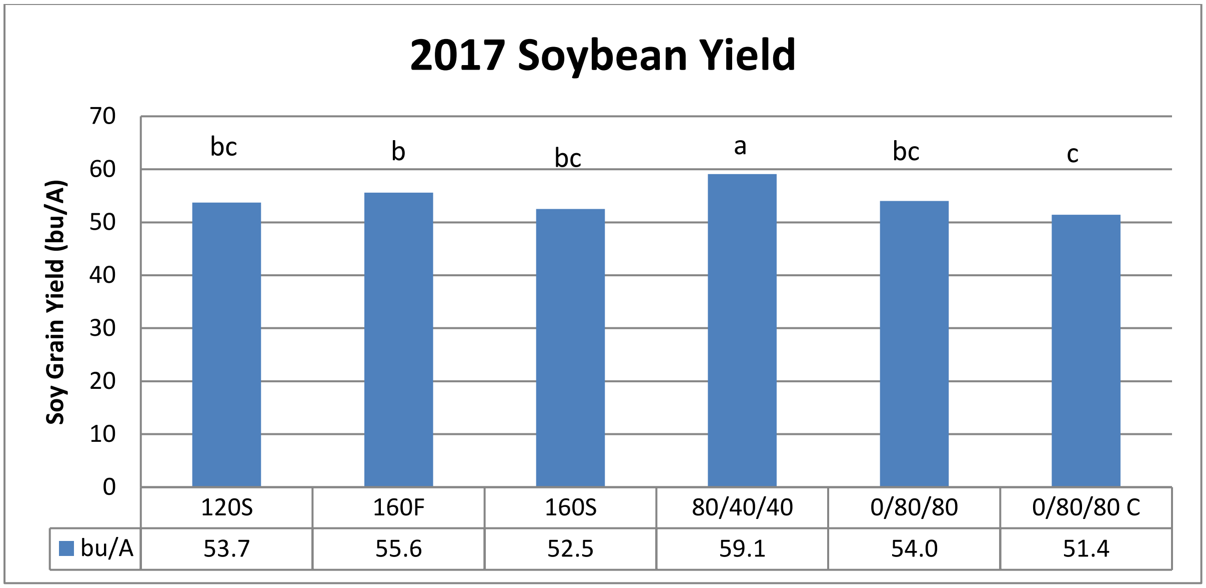
Average corn yields ranged from 181 bu/A with the reduced N rate treatment to a high of 211 bu/A for the 0/80/80 treatment (spring N + side-dress N), similar to 2016 corn yields. Plots experienced green snap in some areas of the field and the variability in the dataset did not produce statistical differences (Letters above bars pertain to Pr>F =0.114).



	120 S	160 F	160 S	80/40/40	0/80/80	0/80/80 C
bu/A	181.1	195.3	198.5	206.5	210.6	203.8

In general, treatments with side-dress N application performed best. The wet conditions of April and May enhanced leaching of fertilizer N and a trend toward lower corn yields was observed for treatments that did not receive a side-dress N application. Oat and radish biomass from the previous fall averaged 0.14 tons/A and did not appear to affect corn yields.

Average soybean yields ranged from 51.5 bu/A in the cover crop treatment to 59.1 bu/A in the 80/40/40 treatment (Note: N treatments were applied to corn during the previous year). Soybean yields were down approximately 35% compared to 2016 yield levels.

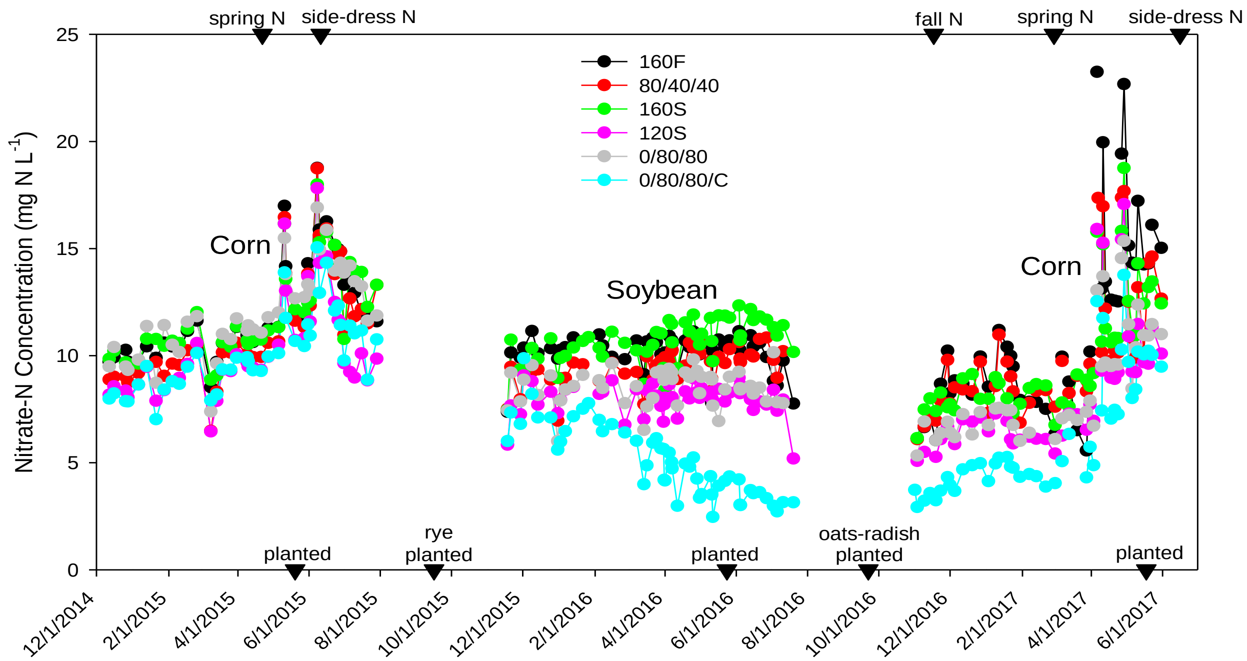


The wet spring delayed soybean planting (June 1) and very dry conditions in August and September greatly limited grain fill. Soybean seed weight was down approximately 25% in 2017 compared to 2016 (130 mg/seed vs. 170 mg/seed), which accounts for most of the yield decrease in 2017. Soybean yield differences were significant across the 6 corn N treatments with the 80/40/40 treatment producing the greatest soybean yield while 0/80/80 C (cereal rye after corn) produced the least yield.

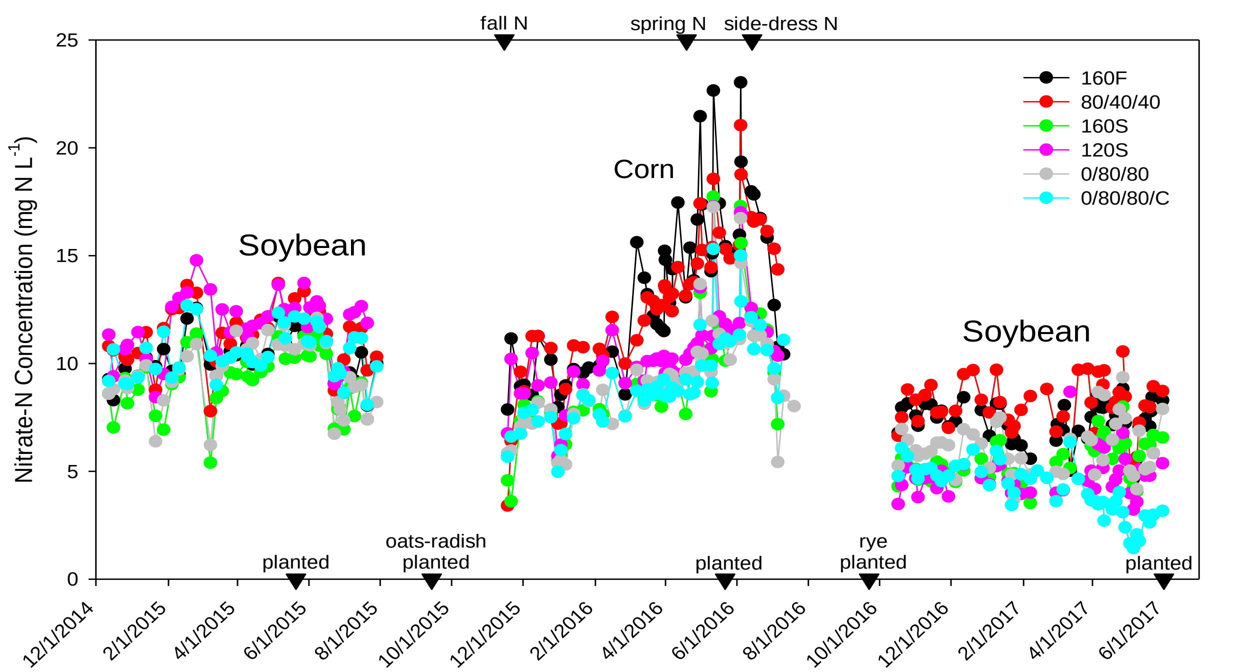
Cereal rye (above-ground mass) accumulated 1.2 tons/A of biomass before being terminated with glyphosate on April 30. Soybean yield was down 5% following cereal rye due to wetter conditions at planting (cover crop residue kept soil from drying as quickly as other plots), which may have produced thinner soybean stands.

In 2017, we collected 1876 tile water samples for a total of 5424 samples collected to date (2014-2017). Each tile water sample is analyzed for nitrate, ammonium, and dissolved phosphorus. The two figures below show the average tile nitrate concentration during the past 3 years (each dot is the average of 3 replicates).

In the Corn-Soybean-Corn rotation, the cereal rye effect (0/80/80 C) on tile nitrate in 2016 was pronounced and led to a >40% reduction in tile nitrate load compared to the 0/80/80 treatment. It does not appear that the oat and radish cover crop after soybean accumulated enough biomass and biomass N to have an observable effect on tile nitrate in 2017. Therefore, it appears that the cereal rye effect on tile nitrate concentration carried over through the following drainage season.
See figure below.



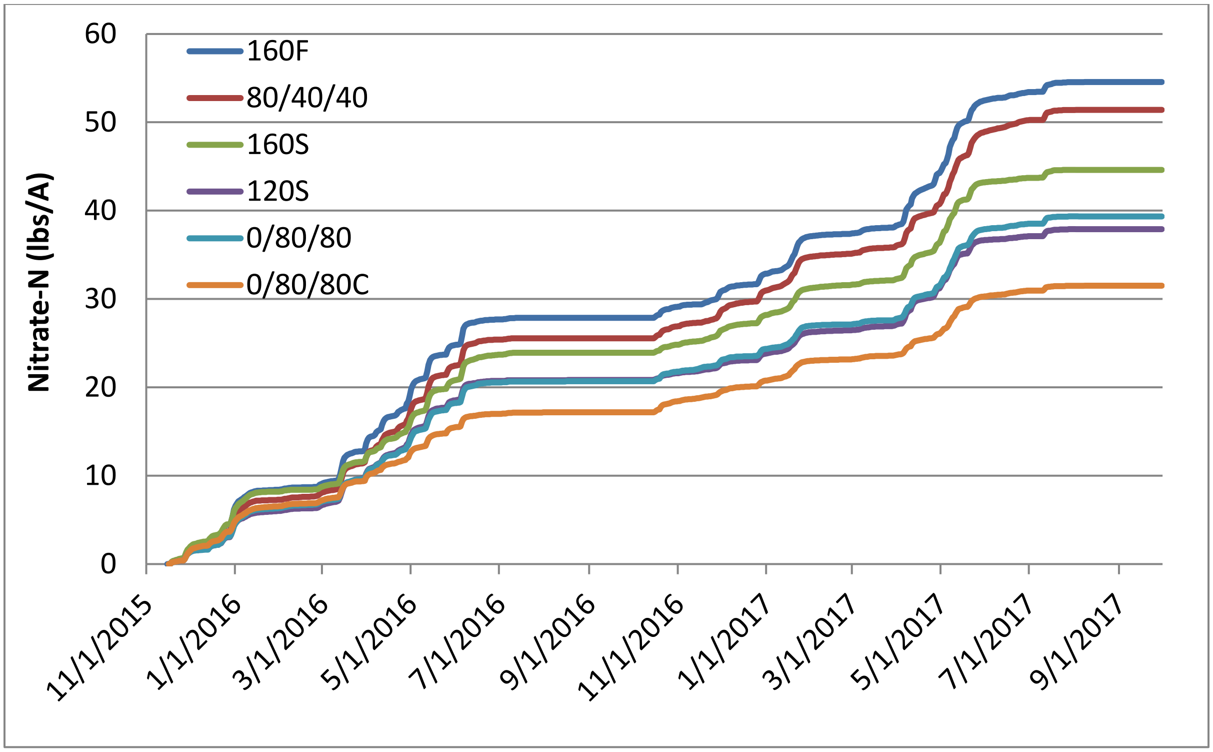
In 2017, when comparing fall N treatments to spring N only treatments for corn, tile nitrate concentrations and patterns were similar and did not separate between treatments as we observed in 2016. Note: we applied spring N on February 28 to match the time when farmers were applying N in the surrounding area. Our data suggest that tile N losses were similar for spring fertilizer N application without an inhibitor compared to fall N fertilizer with an inhibitor.



In the Soybean-Corn-Soybean rotation, we see that the plots that received fall N application in late 2015 continued to have the greatest nitrate concentrations through 2017 (black and red dots). As in 2016, cereal rye decreased tile nitrate concentrations below 2 ppm.

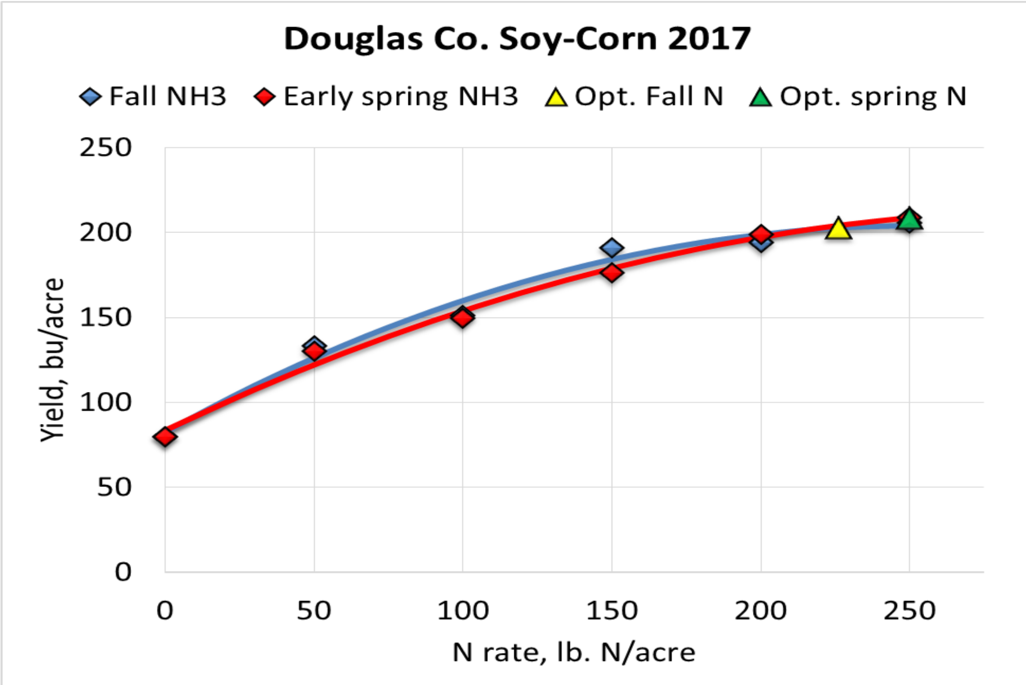
It is interesting to note that the reduced N fertilizer rate treatment (pink dots) is beginning to move lower in regard to tile nitrate concentration in both cropping sequences (Corn-Soy-Corn or Soy-Corn-Soy) in this study. The reduced N rate treatment (120S) has similar tile nitrate concentrations and loads as the spring and side-dress treatment (0/80/80); however, the reduced N rate treatment has lower corn yields (10 to 15% lower).

Over the past 2 years, cumulative tile nitrate loads have separated based on N treatments (i.e. timing and amount of fertilizer N applied).



Fall N treatments (160F and 80/40/40) have lost the most tile nitrate with 54.6 and 51.4 lbs/A, 160S has lost an intermediate amount of tile nitrate with 44.6 lbs/A, 120S and 0/80/80 have lost about the same amount of nitrate with (39.3 and 37.9 lbs/A) and the cover crop treatment (0/80/80C) has lost the least tile nitrate with 31.5 bs/A over the 2 drainage seasons. Overall, the cover crop treatment has produced 43% less tile nitrate load compared to the 100% fall N treatment (160F).

Dan Schaefer setup the N rate trials at this site with a complete fall and spring trial comparison. N rates were from 0 to 250 lbs/A at 50 lbs/A increments. Note: fall N with inhibitor was applied on Nov. 16, 2016 and spring N without inhibitor was February 28, 2017. The figure below shows both trials on one graph.



The corn yield curves are very similar between fall and spring N application and are rather linear. The shape of the curves suggest that N loss limited yields as optimum N rates were above 225 lbs/A. These data also support the results that tile drainage nitrate losses were greatest for these two treatments.

Highlights in 2017

- As in 2016, cereal rye after corn (before soybean) decreased tile nitrate concentrations below 2 ppm.
- The effect of cereal rye on tile nitrate continued through the next drainage season.
- Applying anhydrous in late February without an inhibitor created increased tile nitrate losses, which were similar to tile nitrate losses from fall fertilizer N application with an inhibitor.
- Cumulative tile loads over the past two years show that side-dress treatments reduce tile nitrate loads (without sacrificing crop yields).

Outreach

During 2017, outreach activities included 13 invited presentations by Lowell Gentry at various events such as: the Crop Management Conferences held throughout the state; annual meetings by IFCA and LICA, and local meetings (i.e. Ford/Iroquois County Extension and the Champaign County Farm Bureau. Collectively, we estimate that >1500 people attended these meetings and conferences.

Also, Mr. Gentry presented a webinar for the Soil Fertility Seminar Series, presented 2 lectures at Parkland College, as well as served as a judge for a Landscape Architecture class to help improve class projects for a national design competition using techniques that reduce nutrient loss from agricultural landscapes. They won first place in the 2017 Student Awards at the American Society of Landscape Architects.

We had 2 field days this summer to present our findings from both the Douglas and Piatt County projects.

We have joined a working group of tile drainage researchers from across the Midwest to develop standardized measurements for greater relevance among replicated tile drainage studies. This has led to a joint project funded by FFAR which adds supplemental funding for more crop plant measurements as well as K measurements in crops, soil, and tile water.

This work in conjunction with our other NREC studies has led to a cover crop guide book that was edited by Jean Payne.

2017 Project Budget = $213,573

Expenditures

Salary & Wages	$126,721
Fringe Benefits	$39,937
Materials and Supplies	$6,402
Equipment	$0
Travel	$839
Services	$22,905
U of I Indirect Costs	$19,152
Total	$215,955
Balance	(-$2,382)

We thank NREC for their continued support of this research. All 4 of our NREC projects tie together well and collectively are providing valuable information about N and P loss in tiles under a variety of agricultural systems. This study will provide needed information on nitrogen management systems and resulting tile nitrate losses while supporting high-yielding row crop agriculture.